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DESCRIPTION

Material and process for producing a corrosion- and wear-resistant layer by thermal spraying

The invention concerns a material and a process for producing a corrosion- and wear-resistant layer on a substrate by thermal spraying.

Anti-corrosion and anti-wear layers are usually applied from powder mixtures of various kinds to surfaces to be protected in manufacture or for maintenance purposes. Thermal spraying processes or vapor deposition processes such as CVD (chemical vapor deposition) or PVD (plasma vapor deposition) are mainly used for that purpose. The CVD and PVD processes make it possible to apply thin anti-corrosion and anti-wear layers based on an oxide or hard substance, in particular in mass production. Electrochemical or galvanic processes are also used.

Layers of a layer thickness of more than 0.1 mm are primarily provided by means of thermal spraying. The corrosion- and wear-resistant layers produced by thermal spraying mostly involve metallic or oxidic layers in which hard substances are incorporated for enhancement purposes.

One of the major problems with regard to thermal spraying processes is the production of layers of constant properties and quality. For that reason, it was possible for thermal spraying processes to be used only to a limited extent on substrates or parts with high demands in respect of quality in mass production.

Tests with a choice of the material in regard to its chemical composition or its form - for example on the one hand the wire diameter of a filling wire or on the other hand the grain size distribution and the grain shape of the spray powder - did not result in an adequate increase in

quality. Changes to the spray installations also did not contribute to better quality.

Attempts were made to provide protection from wear and corrosion by means of layers applied by thermal spraying, comprising iron oxide or magnetite. In all attempts of that kind it was found that the quality of the respective layer, in regard to the layer structure, could be safeguarded to some degree only at great cost.

In consideration of those factors, the inventor set himself the object of improving the production of a constant, wear- and corrosion-resistant surface coating on an oxide base, by means of thermal spraying.

That object is attained by the teachings of the independent claims; the appendant claims set forth advantageous developments. The scope of the invention also includes all combinations of at least two of the features disclosed in the description, the drawing and/or the claims.

In accordance with the invention the layer material for production of the corrosion- and wear-resistant layer has at least 20% by weight and preferably more than 30% by weight of magnetite (Fe_3O_4, also with additions of Fe_2O_3); this may involve pure magnetite (Fe_3O_4) or a material comprising magnetite and at least one further metallic material, possibly also magnetite and at least one intermetallic compound.

In addition a material with an addition of carbide or carbides or nitride or nitrides or silicide or silicides or boride or borides or oxide or oxides has proven to be advantageous or a material whose additives are mixtures of metals, intermetallic compounds, carbides, nitrides, silicides, borides and/or oxides.

The additions of up to 50% by weight and preferably up to 40% by weight to the magnetite may be for example Cr, CrNi or ferritic steels.

In regard to the hard substances, carbides, nitrides, silicides, borides and oxides have proven successful as additions. In regard to the carbides, carbide-forming agents such as tungsten, chromium, molybdenum, niobium, tantalum, titanium, vanadium or the like are

suitable. The addition of the carbides should be limited to at most 30% by weight, preferably 20% by weight. With the borides and nitrides as additives at that level, improvements in the properties were found. Oxidic additions of chromic oxide (Cr_2O_3) of an order of magnitude of between 1 and 40% by weight, preferably between 5 and 30% by weight, also show good results.

In order to achieve a high quality the spray materials in powder form must involve a grain size of between 0.05 and 150 μm, preferably between 0.1 and 120 μm. In regard to the mixtures of various powder materials, it is recommended that they should be agglomerated or spray-dried in order to prevent the mixture from separating and in order to improve the flow characteristics.

When using spray materials in wire form, with a high proportion of magnetite, it is possible in accordance with the invention to produce a filling wire from a metal sheath and magnetite powder.

In accordance with the invention, for applying the wear-resistant and/or corrosion-resistant layer, all thermal spray processes such as autogenous flame spraying, high velocity flame spraying (HVOF spraying), plasma spraying in air (APS), shroud plasma spraying (SPS), vacuum spraying (LPPS), high-power plasma spraying (HPPS), autogenous wire spraying or arc wire spraying can be used.

On-line monitoring and control is effected with a combination of various processes which make it possible to measure the temperature of the particle or the degree of melting, the particle size, the speed, the impingement thereof on the substrate and the rise in temperature of the layer and the substrate during the spraying operation. The measurement signals are then passed to the computer of a control installation for the spraying apparatus and the flame parameters and the power involved are matched to the values in question.

The inventor therefore found that it is possible to provide a coating which satisfies the above-mentioned requirements if the material used is